Field Raman Spectrograph for Environmental Analysis

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Abstract

To help meet DOE's need for better, faster and safer field analytical methods we have developed a portable Raman spectrometer that can be used to identify and measure a wide variety of environmental pollutants. The spectrograph is unique in its optical configuration, providing both full Raman spectral coverage and high resolution with no moving parts. These features are achieved by combining cross-dispersing prisms and an echelle grating to produce a two-dimensional spectrum that is then read by a CCD detector array. EIC has developed computer software to covert the detector data to a conventional, one-dimensional spectrum corrected for instrument response. The instrument can employ different lasers as sources for Raman scattering; however, we have primarily used a near-infrared diode laser emitting at 785nm to help reduce fluorescence inerference from many samples. Other advantages of this laser are its small size (6 x 6 x 12 in), frequency stability when coupled to fiber optics, and high optical power (300 mW).

Fiber optic probes are interfaced to the instrument for remote, *in situ* detection in hazardous or difficult to access locations. Raman probes designed to "look" into excavated waste bottles without opening them, through a window in a cone penetrometer rod, or into the sludge of a hazardous waste tank have been developed. Micro-optical components are used in all of these small (0.5 in diameter x 5 in long) probes to provide high quality Raman spectra without interference from background generated in the optical fibers.

Over the past year, we have been evaluating and improving instrument performance. A user-friendly software platform has been developed along with a Raman spectral database of 200 contaminants found at DOE sites. We have demonstrated quantitative detection of analytes from neat (100%) down to millimolar concentrations in water. Mixtures of up to 10 similar chemicals (e.g., chlorinated hydrocarbon solvents, including isomers) have been resolved into their individual components. In addition, important ionic components in real waste tank supernates have been analyzed successfully in an ORNL hot cell facility.

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